i-DRILL Modeling Optimizes High-Profile Horizontal Well, Saving 2.6 d and USD 1,300,000, Offshore Brazil

CHALLENGE
Directionally drill a high-profile horizontal well while efficiently meeting operational objectives and maximizing ROP in a carbonate reservoir.

SOLUTION
Use i-DRILL* modeling to design a drilling system and determine the optimal range of operating parameters. Utilize a PowerDrive Xceed* RSS and a PDC drill bit for the harsh drilling environment.

RESULT
The i-DRILL designed drilling system doubled ROP compared to correlation offset, saving the operator 2.6 d and USD 1,300,000. As well, reduced shock and vibration, and improved drillbit dull grading were experienced compared to plan.

Accurate modeling system to select correct PDC bit required
Drilling activity in Campos Basin, offshore Brazil has gained worldwide attention with the recent completion of a high-flowing, horizontal, oil producer by operator OGX Petróleo e Gás Ltda. Exploitation of the reservoir began in December 2009 as a result of drilling exploratory well 1-OGX-3-RJS, which led to the discovery of the large Waimea hydrocarbon accumulation. After analysis, the company concluded the most efficient way to develop the field would be with extended reach horizontal drilling techniques. The Waimea Horizontal campaign estimates to drill approximately 40 development wells. However, the high-cost offshore environment and lack of experience drilling the type of directional/horizontal profiles that the project required was a concern. Before commencing operations, an i-DRILL design optimization project was launched to ensure efficient and cost effective borehole construction would result when the company attempted its first development well: 9-OGX-26HP-RJS.

i-DRILL study
A comprehensive i-DRILL modeling project was planned to determine contact forces on the BHA. These included an examination of rock strength analysis, fundamental PDC shearing action and the effects of variation in drilling parameters. The goal would be to maximize ROP and mitigate drillstring vibration through several efforts: Select the best PDC bit and directional steering tool and determine the best combination of drilling parameters. Each component would be evaluated on four criteria:

- Lateral, axial and torsional vibration
- Surface and downhole torque
- Instantaneous ROP
- Directional prediction (buildup rate and walk rate)

Before running the dynamic simulations, it was essential to calibrate the model with offset data to ensure accuracy of the optimization process. A virtual representation of the application was produced to quantitatively investigate iterative changes to BHA components and bit design. In this case, ROP was the reference point for adjusting the model, but the process enables other variables to be used such as vibration and torque. To gain inferences about the target formations, DBOS* drillbit optimization system was used to analyze rock strength based on offset data. To simulate these characteristics, several rock files were tested in the IDEAS* platform and analysis laboratory to find a sample that would best reflect the physical properties of the formation.
CASE STUDY: Application-specific design delivers optimum performance

Selecting proper PDC bits
The next step was to select the appropriate PDC bit candidates for the i-DRILL investigation. Based on previous experience, engineers selected three 8½-in IDEAS platform certified PDC designs: A MDi613, MDi616, and a MDSi813 were chosen for the simulation. Personnel from Schlumberger recommended a fixed BHA with a PowerDrive Xceed point the bit RSS and nine combinations of operating parameters: 10, 15, 20 klfb WOB and 120,130,140 rpm surface rotary speed. The Finite Elements Analysis (FEA)-based modeling system was then used to run dynamic simulations with various combinations of bits and parameters. The virtual analysis revealed all three PDCs met surface torque requirements, but the MDi613 was eliminated because it did not present the best dynamic response for this particular application. Additional testing showed the MDi616 displayed better directional response compared to the MDSi813 design. After reviewing all simulation results, engineers determined that an 8½-in MDi616LEB run with 10,000 lbf WOB and 140 rpm rotary speed would drill the lateral hole section with minimum vibration and at a maximum ROP. OGX and Schlumberger personnel agreed with the analysis and supported the recommendations.

Performance results
After drilling to the kickoff point at 3,746 m, the MDi616 was run on a PowerDrive Xceed RSS and drilled a 1,000 m, 8½-in lateral borehole into the carbonate pay zone with minimal vibration and no directional issues. The bit delivered all trajectory requirements, doubled ROP compared to the correlation offset, and was pulled in excellent dull condition (0-0). The driller closely adhered to the optimum parameter combination (WOB/RPM) produced by the i-DRILL drilling system analysis. As a result, the operator saved 2.6 days of rig, for an approximate savings of USD 1,300,000 in rig time as compared to the AFE plan.